International Journal of Environment, Ecology, Family and Urban Studies (IJEEFUS)
ISSN(P): 2250-0065; ISSN(E): 2321-0109
Vol. 7, Issue 2, Apr 2017, 29-34

FROM AQUEOUS SOLUTION ADSORPTION OF HAZARDOUS DYE USING LOW COST MATERIAL AND ITS KINETICS STUDIES

HEMANT KUMAR

Department of Chemistry, Ramjas College, University of Delhi, India

ABSTRACT

To develop a methodology for the removal of a Toxic dye Rhodamine B (RB) from aqueous solution by using low cost, rapid, economical and biodegradable, natural material Spirulinaplatensis (SP) Employing the batch extraction method. The component of like saccharides, fat and vitamins containing functional group like carboxylic group which attract the positive charge of dye by electrostatic interaction with pollutant and water hazardous pollutant. The presence of dyes in water bodies act as pollutant and cause hazardous effect on natural resources, aquatic life as well as to human being. The interaction of dye with Spirulinaplatensis was investigated as a function of pH of the aqueous solution of the dye, contact time for batch extraction and the initial concentration of the dye in aqueous solution. We have also explored the efficiency of these for removal of suspended solids in water separation in a single step. Highest 62.13% uptake efficiency recorded was for 60 mg/L of 25 mL solution concentration onto 25mg of Spirulinaplatensis.

KEYWORDS: Rhodamine B, Natural Spirulinaplatensis and Adsorption

Received: Jan 26, 2017; **Accepted:** Mar 06, 2017; **Published:** Mar 10, 2017; **Paper Id.:** IJEEFUSAPR20174

Original Article

INTRODUCTION

Dye is a well popular chemical material and is also known to bio accumulate in aquatic fauna and is able to transfer to higher food chain [01], causing possible health liabilities of consumers. The high visibility of dye at low concentration due to this reduces photosynthetic activities of aquatic plant and an alga, leading to reduction in dissolved oxygen thereby harming aquatic life [02].Industrial wastewater presents a challenge to conventional physicochemical and biological treatment methods. Considering both volumes discharged and effluent composition, the waste water generated by the textile industry is rated as the most polluting among all industrial sectors.

Among the various conventional methods of waste water treatment, adsorption has been found to batter and combine economic advantage, design and operational simplicity, and with the uptake of very low concentration of toxicants [03]. Activated carbons also have been employed in effluent treatment over the years and have been found to exhibit great affinity for dye and organic compounds [04-05]. However, due to the precursors used for the preparation of commercial activated carbons, it has been found to be economically unviable and therefore other precursors are being sought [06-07]. Adsorption is one of the most effective methods and activated carbon is the preferred adsorbent widely employed to treat wastewater containing different classes of hazardous dyes, recognizing the economic drawback of commercial activated carbon [08].

The blue-green algae *Spirulinaplatensis* is available in large quantities because it is widely cultivated worldwide; its annual production is about 2000 tons [09-10]. *Spirulina* biomass contains a variety of functional

groups such as carboxyl, hydroxyl, sulphate, phosphate and other charged groups which can be responsible for the binding with different variety of pollutant material including dye and organic material [11-12].

The objectives of this study include the characterisations of the adsorbent, the investigations of the dye removal at different adsorbent dosage, initial pH, dye initial concentration and contact time. Adsorption isotherm, kinetics were also investigated.

EXPERIMENTAL

Materials

The Spirulinaplatensis and Rhodamine dye used in the present study was obtained from Thomas Baker Chemicals Ltd., Mumbai, India.

Adsorption Studies

The aqueous dye solution was found to be stable over pH range 4–10 the lambda max remains constant at 556nm [13]. All the Batch experiment was performed at room temperature (30 ºC). Employing the batch method, the adsorption behaviour of Rhodamine B onto Spirulina was investigated as a function of the pH of the aqueous dye solution, the contact time for batch adsorption and the concentration of the aqueous dye solution.

Calibration Plot

This dye in aqueous solution shows pH in dependent absorption behaviour in the pH range of 4.0-10, the lambda max remains constant at 556 nm therefore and calibration plot was prepared at pH 5.0. The Beer – Lambert's law was valid in the range of 1 ppm to 10 ppm with slope 0.0862 and correlation coefficient 0.9964 as shown in **Figure 1**.

After adsorption study centrifugation and then supernatant thus obtained was used for the spectrophotometrically estimation of the absorbance of the unadsorbed dye in solution at a wavelength of 556 nm via a Jena AnalytikSpecord 250 spectrophotometer. The concentration of the unadsorbed dye was determined from the corresponding Beer–Lambert plot. The percentage adsorption of dye from the aqueous solution was calculated by the following equation.

$$\textbf{Percentage Adsorption of Dye} = \{(C_i - C_e) / C_i\} \times 100$$

Where C_i is the initial concentration of dye solution and C_e is the concentration of dye in the supernatant at the equilibrium stage

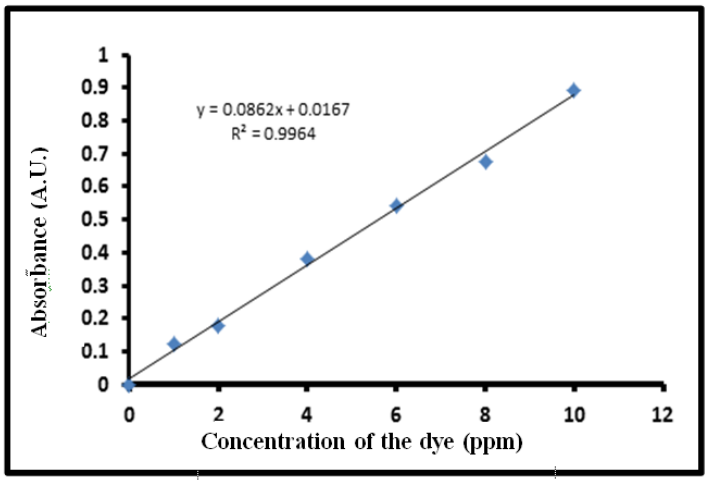

Figure 1: Absorbance as Function of Concentration of the Dye

Adsorption of Dye as a Function of the pH

In the adsorption process pH of the dye solution plays an important role, particularly on adsorption efficiency, since *Spirulina* possessed a greater and negatively charged surface. In contrast, the adsorption capacities of Spirulina towards dye was increases continuously from pH 1 to pH 9 and suddenly decrease at pH 10 as shown in **Figure 2**. It assumed as at higher pH value *Spirulina*is surrounded by negatively charge and hence more adsorption takes place.

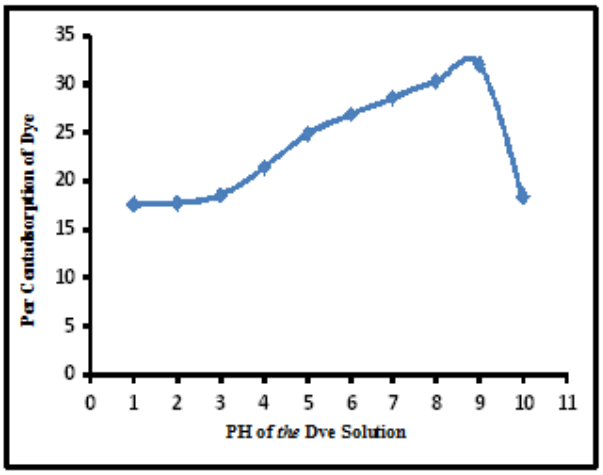

Figure 2: Adsorption of Dye as a Function of the pH

Adsorption of Dye as a Function of the Contact Time Dependent

As a function of contact time show up to 120 minute, the uptake of dye by *Spirulina*is very slow with adsorption attaining a value of 12% with in 20 minute and 21% with in 40 minute being maintained upto 120 minute as shown in **Figure 3**.The maximum uptake was only 33.34% which was attained after 100 minute after that it attains the equilibrium.

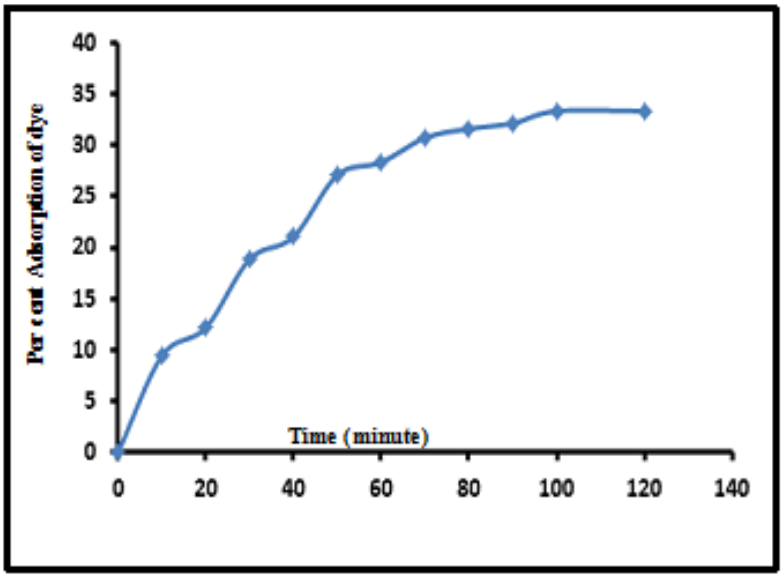

Figure 3: Adsorption of Dye as a Function of the Contact Time

Adsorption of Dye as a Function of the Initial Dye Concentration

It was observed that on increase of the initial dye concentration there is an increased the uptake of dye up to 60 ppm of concentration. Maximum adsorption efficiency of dye was observed at lower concentration of dye and on increasing dye concentration from 60 to 100 ppm, adsorption efficiency decreases gradually as shown in **Figure 4**. At 60 ppm 62.13% dye adsorption was found. The decrease in the dye uptake with increasing the concentration of dye might be due to the lack of available adsorption sites.

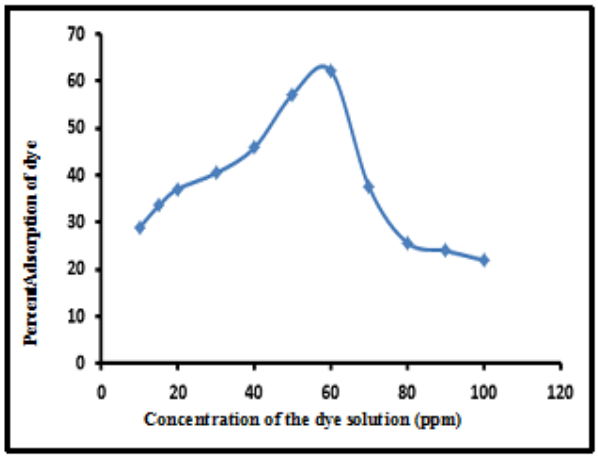

Figure 4: Adsorption of Dye as a Function of the Initial Dye Concentration

CONCLUSIONS

The present study indicates that Spirulinaplatensis is a good biodegradable and natural adsorbent material and it can be used for the removal of Rhodamine B dye from wastewater. Spirulinaplatensis contain some major constituents like saccharides, fat and vitamins containing functional group like carboxylic group which attract the positive charge of dye by

electrostatic interaction. Maximum 62.13 % of dye uptake on 15 mg of Spirulinaplatensis for and 60 mg/L of 25 mL dye solution was observed. So we can say Spirulinaplatensis was good adsorbent material for cationic dye.

ACKNOWLEDGEMENTS

We are grateful to University of Delhi, India, for providing R&D Grant to support this study. We also thank from University Science Instrumentation Center (USIC), University of Delhi.

REFERENCES

1. *Anliker, R., & Moser, P. (1987). The limits of bioaccumulation of organic pigments in fish: Their relation to the partition coefficient and the solubility in water and octanol. Ecotoxicology and Environmental Safety, 13, 43–52.*
2. *Ahmed, T. F., Sushil, M., & Krishna, M. (2012). Impact of dye industrial effluent on physicochemical characteristics of Kshipra River, Ujjain City, India. International Research Journal of Environmental Sciences, 1, 41–45.*
3. *Foo, K.Y. and Hameed, B.H, (2009), Ashort review of activated carbon assisted electrosorption process: an overview, current stage and future prospects, J. Hazard. Mater. 170, 552–559.*
4. *Yuen, F.K.and Hameed, B.H, Recent developments in the preparation and regeneration of activated carbons by microwaves, Adv. Colloid Interface Sci, DOI: 10.1016/j.cis.2008.12.005*
5. *Sekaran G, Shanmugasundaram K. A, Mariappan M and Raghavan K.V, (1995), Indian J Chem Technol., 2, 311.*
6. *Tan, I.A.W., Ahmad, A.L. and Hameed, B.H., (2008), Preparation of activated carbon from coconut husk: optimization study on removal of 2,4,6-trichlorophenol using response surface methodology, J. Hazard.Mater. 153, 709–717.*
7. *Santhi, T., Manonmani, S. and Smitha, T., (2010), Kinetics and isothermstudies on cationic dyes adsorption onto AnnonasqumosaSeedActivated Carbon. Int. J. Eng. Sci. Technol., 2(3),287–295.*
8. *Arivoli S, (2007), Kinetic and thermodynamic studies on the adsorption of some metal ionsand dyes onto low cost activated carbons (Ph D., Thesis), Gandhigram RuralUniversity, Gandhigram, India.*
9. *Elekli A. C and Yavuzatmaca, M., (2009), "Predictive modelling of biomass production by Spirulinaplatensisas function of nitrate and NaCl concentrations", Bioresour. Technol., 100, 1847–1851.*
10. *Elekli A. C and Yavuzatmaca, M and H. Bozkurt, (2010) "An eco-friendly process: predictive modeling of copper adsorption from aqueous solution on Spirulinaplatensis", J. Hazard.Mater., 173, 123–129.*
11. *Seker, A., Shahwan, T., Eroglu, A., Yilmaz, S., Demirel, Z and Dalay, M., (2008) "Equilibrium thermodynamic and kinetic studies for the biosorption of aqueous lead(II), cadmium(II) and nickel(II) ions on Spirulinaplatensis", J. Hazard. Mater., 154, 973–980.*
12. *Dotto, G. L., Lima, E. C. and Pinto, L. A. A., (2012) "Biosorption of food dyes onto Spirulinaplatensisnanoparticles: equilibrium isotherm and thermodynamic analysis", Bioresour. Technol., 103, 123–130.*
13. *Kant, A., Gaijon, P. and Nadeem, U. (2014) Adsorption studies of rhodamine b from aqueous solution using low cost Material: equilibrium and kinetics studies, International Journal of Current Research, 6(8), 7790-7796.*